TURJOEM
The Turkish Journal of Occupational / Environmental Medicine and Safety

The Turkish Journal of Occupational / Environmental Medicine and Safety

2017; Volume 2, Issue 1(3):165-173 Web: http://www.turjoem.com ISSN : 2149-471

INVESTIGATION OF THE PETROLEUM POLLUTION CAUSED BY THE SHIP SOURCE IN ISTANBUL STRAIT

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ABSTRACT

Introduction

The Istanbul Strait is one of the world's most dangerous natural waterways in terms of sea traffic. Istanbul strait, which have great strategic importance, can cause environmental disasters because of the sea accidents that the may occur. Petroleum pollution that can arise from these vessels can negatively affect the structure of sea water and the marine life.

Aim of the study

In this study, oil pollution in İstanbul Strait, accidents and investigated scales were researched, the effects of water on dissolved petroleum and diseases that can occur in people consuming marine products. In addition, methods of fighting against petroleum pollution has been assessed at available resources.

Methods and Materials

Turkish Statistical Institute datas, Turkey Environmental Status Report (2008), Prof.Dr. Kasım Cemal Güven and Prof. Dr. Bayram Öztürk's books on Marine Pollution Analysis Methods (2005) and International Covenants and the thesis studies in the references section reseached by author fort his study.

Results

Hydrocarbons at sediments and in the sea water of the İstanbul Strait between 200-2004 were higher than the standards. Therefore ihydrocarbons are thought to have carcinogenic effect in terms of human health, the consumption of hydrocarbons-affected marine products also puts human health at risk.

Conclusions
In order to prevent oil pollution in the İstanbul Strait, it is necessary to reduce the number of sea accidents and it is necessary to intervene as soon as possible to the petroleum pollution which may be the result of sea accidents.

Keywords: petroleum pollution, sea pollution, Istanbul Strait , tankers

INTRODUCTION

With connecting the Asian and European continents, hosting one of the most crowded cities in Europe which contains historical and natural beauties Istanbul Strait is one of the most important natural waterways in the World. Also the Istanbul Strait has one of the most dangerous and heavy maritime traffic with 25,000 local marine movements and an average of 9000 tankers per year, hosting 52,000 nonstop passengers.
The aim of this study is to investigate the oil pollution and the scale of the accidents effects of organisms that live in water and soluble oil products that may occur reveal ailments in people that consume from the procurement in the Istanbul Strait, which has scenes of wars in History and has geopolitical and strategic importance. In addition, the possible ways of interfering with oil pollution that may occur and the possibilities will be evaluated within the scope of this study.

METHOD

This study was carried out by Eren SALİHOĞLU in December 2016 with Turkish Statistical Institute datas, Turkey Environmental Status Report (2008), Prof.Dr. Kasım Cemal Güven and Prof. Dr. Bayram Öztürk's books on Marine Pollution Analysis Methods (2005) and International Covenants and the thesis studies in the bibliography section.

RESULTS AND DISCUSSION / INFORMATION OBTAINED AND INTERPRETATION

The Istanbul Strait which is a waterway with the busiest and most dangerous traffic in the world After the Malacca Strait (1), also has a very important strategic and geographical position. The legal status that is determined by the Montreux Turkish Straits Agreement ,each day 150 non-stop ship movements take place carrying about 23 dangerous cargoes and 2500 regional maritime traffic movements that carry 2 million people. (2) Due to its geographical structure, narrowness, strong currents, sharp turns, varying climatic conditions, It creates a difficult sea passage way in Istanbul Strait. Any maritime accident that may occur can affect over 15 million people living on and cause an enormous environmental disaster.

1. Tanker Traffic in the İstanbul Strait

Marine transport is preferred because it can be transported in high volume at once and is a safe transportation method. With the increase in petroleum demand in the world and the construction of the high-capacity tankers, it is also the most widely used transport type for the export of petroleum. In 2013, 2292 of the 9006 tankers passing through the Istanbul Strait carried 117.1 million tons of crude oil and fuel oil products in total (Figure 1). This corresponds to 82% of the total dangerous cargo passing through the İstanbul Strait. The oil transported by tankers can be dispersed in the sediment by spreading and dissolving in the sea surface in case of any accident that may occur in the İstanbul Strait or in case of a leak which may arise from the vessels.

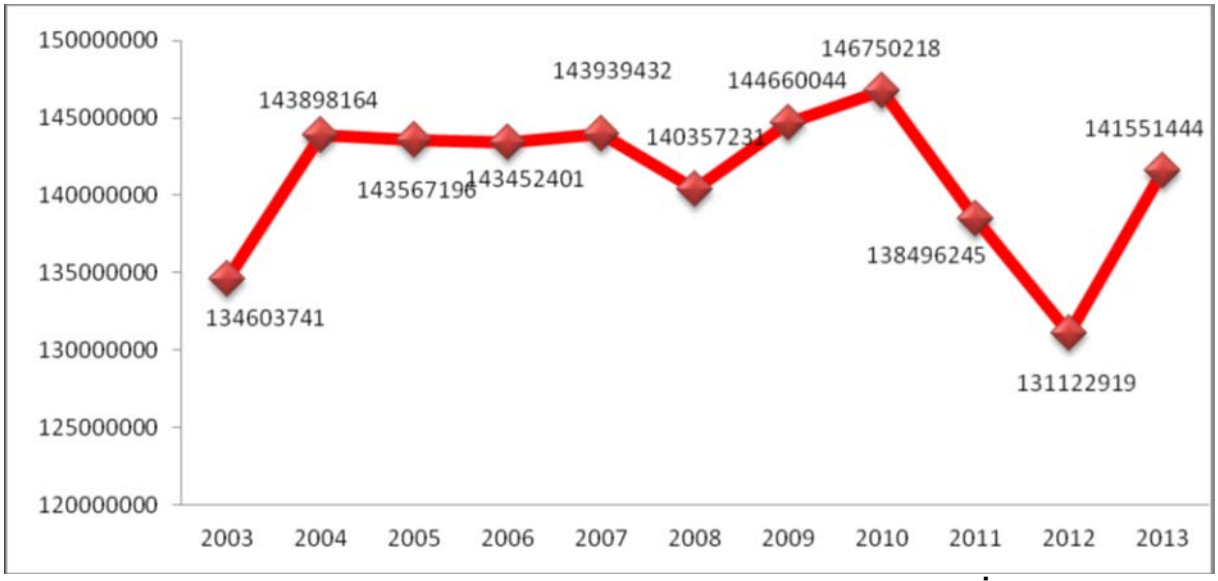

Figure 1: The amount of dangerous cargo passing by tankers from the İstanbul Strait(9)

2. Composition of Petroleum and its Forms at Water Dispersion

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Petroleum is a mixture of thousands of hydrocarbon molecules and is a water-insoluble, slightly water-less mixture. The moment it flows into the sea, it spreads according to the sea condition.So that when a liter of petroleum is poured into the sea,it can spread to an area half the size of a football field. When petroleum is poured into the sea, a series of physical and chemical reactions occur in its interaction with the water too. (3)

As a result of a tanker accident, 16% of the leaking petrolium pours out to the water, 15% is evaporated and mixed with the atmosphere. %22 biodegrades, 3% remains bulk in open sea, 16% reach the shore and 28% sink to the sea bottom. Because the density of Petrolium and and its derivatives is average 10% less from sea water, the materials on the surface can not protect their position until reaching the shore. Due to evaporation of volatile kinds of such products, their volume decreases and the remainder is mixed with the water at the end of the emulsion process and decomposed by photooxidation and oxidation. Thus after being poured into the sea, the petrolium and its derivatives are reduced 85% by volume,while the remaining part which is a black intense substance or reaches the shore. In case of petroleum products coming into the sea near the coast; if there is not enough time to complete the reactions described above, a tacky layer is formed on all surfaces where they come into contact at the shore. The toxicity of petroleum products causes some compounds with low boiling points to cause anesthetic and narcotic effects on some of the organisms in the water. (4)

3. The Effects of petroleum Spillage on Marine Living and Human Health

Some cyclic compounds on the petroleum dissolve after a portion of the spilled oil is naturally spread over the sea. Some of these cyclic compounds found in petroleum have carcinogenic effects for vital health. In Table 1, those marked with a "+" indicate compounds that are found in the petroleum oil and have a carcinogenic effect.

Table 1: Carcinogenic effect of substances found in petroleum (5)

Tek aromatik gruptan:		Benzen Toluen	+
İki halkalı	:	Naftalen	-
Üç halkalı	:	Fenantren	-
		Antrasen	-
		7.10 dimetil antrasen	+
Dört halkalı	:	Piren	-
		Benz(a)antrasen	+
		Krisen	0/+
		Fluoranten	+
Beş halkalı	:	Benzo(ghi)perilen	+
		Benzopiren	+
Yedi halkalı	:	Coronen (halkalardan biri aromatik değil)	0/+

Water-soluble petroleum fragments may accumulate on sensitive epithelial tissues (gills, mucous membranes, etc.), clog them and cause them to deteriorate. The filtering mechanisms affected animals can swallow up enough oil that may show poisonous effect beside their bad nutrition. Animals which gills are infected with petrol can not achieve oxygenation (oxygen uptake) and soluble hydrocarbons can enter the blood circulation system via the respiratory system. Especially when natural or chemical solubilisation causes the oil to mix with the water column at high densities for days, such conditions are common in molluskers, offshore and bottom fishes. (6)

Petrolium primarily affects the organisms that need the sea surface to supply their basic needs, such as food and nutrition. In the first place, even if certain organs are influenced, as the living creatures move, other organs are also affected. Marine birds and mammals are among the most risky living groups among the petrolueim-damaged groups. Because these creatures need the sea surface to live. Also the poisoning characteristic of the oil vapor irritates the eyes and nose, damages the metabolism and even blockages the complete respiratory system. The plankton on the sea surface, is are first step in the food chain, are also affected by this pollution. When pollution occurs, the first creatures to be affected by the reduction of plankton are marine mammals. (7)

A fire that may be the result of burning petrolium from ships' accidents may cause nitrogen and sulfur compounds and these can turn into unwanted nitric and sulfuric acid also these may cause acid rains. Pollution on the shore is directly related to the geographical structure of the coast. The high rocks provide a suitable surface for the petroleum spill with its large surface. However, this pollution is easily cleared by wave movements. On the other hand, if the rocks are low, especially in tidal areas, and if the water is below the sea surface at high sea level times, the pollution will be more serious. Sand and pebbles are more affected by pollution. Many hydrocarbon species penetrate deeply into the gaps between the sand and gravel granüle.Therefore it is quite difficult to clean completely... And That's why So smaller granular beaches are less affected because it is difficult for the petroliuem spill to sink deep. After the pollution, the petroliuem residues that descend to the depths can come back to the surface by the wave movements that hit the shore. In this case, the cleaned coast becomes polluted again. Even this pollution can get mixed up again. (7)

When the petroleum components mix into the water column, they are absorbed by the biological beings in that area and these creatures can get poisoned. This poisoning can occur violently and can cause sudden death or contacting with ingesting oil can cause serious deterioration of its essential functions. Petroleum can affect organisms in their first stages of development more than adults, because eggs, larvae and pups of the same species are more susceptible than adults. When the organisms rates of growth and reproduction,such is resistance to strasse or biological attack (disease, parasites, hunters) is reduced, the poison effect may show later. (6)

Many laboratory studies are carried out to determine the most toxic components of different petroleum. These are mainly high solubility and thus aromatic components that marine organisms can quickly find (Polycyclic or multi-ring aromatic hydrocarbons or PAH). The movement of the

surrounding waters to obtain the intensities of the aromatic components is an important sign. (6) Image 1 shows the values of hydrocarbons from sea-dissolved petroleum affecting marine organisms according to their density in water.

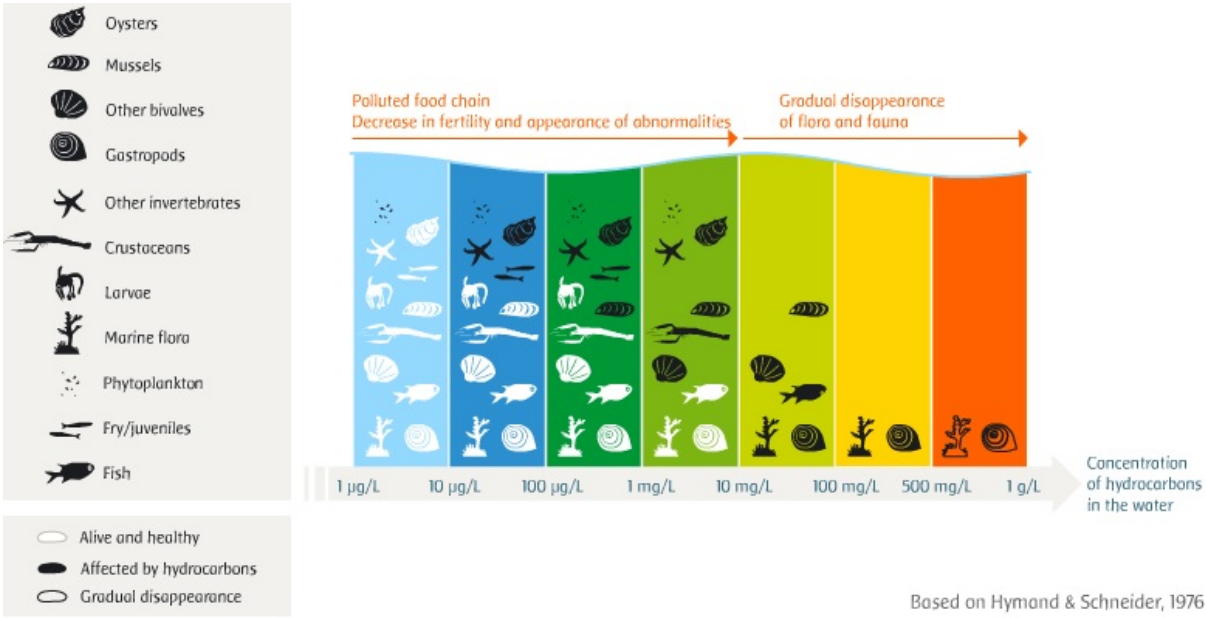

Image 1: Effect of hydrocarbons on marine organisms (6)

Polycyclic aromatic hydrocarbons are contaminants that can be continuously present in the marine environment because they have high durability and the resources(Burned fuel, various industries, burned wastes, etc.)they come from are diverse. PAHs with higher molecular weight which are potential carcinogens and due to the effects of genetic alteration, are the main pollutants that pollute marine and terrestrial ecosystems. Their toxic effects are caused by the formation of metabolites of organisms that cause DNA degradation. (6)
In the İstanbul Strait, aquaculture production is produced in many different ways, such as amateur angling, stretching netting and hunting, mainly carried out by the netting boats. If these fish nets encounter an oil spill, they will be damaged. Even after hunting the quality and flavor of the fish would be degraded , which is caused by the oil poured into the fish's skin. Any oil pollution that may occur will affect the production of fishery products negatively not only in the current date but also in later periods. (7)
Hydrocarbons that act as carcinogens in the human body cause many diseases as a result of the depletion and consumption of marine organisms that contain water-dispersed hydrocarbons in their bodies.

4. Petroleum Pollution Measurements in the İstanbul Strait

The limit of petrolium pollution FAO/IMCO/WHO/WAO/IAEA/UNEP (1989) in seawater is 13 µg/L PAH.(Limit in drinking water is 0.2 µg/L PAHs (WHO)) Above this average is shown as pollution. The pollution limit in the coastal sediment is 10 µg/g.(Dry weight) (National Academy of Science, 1975). (5)
As a result of a survey conducted, the results of petroleum pollution (max. Values) in the sediments of the Bosporus and Marmara Sea is shown in Table 2.

Table 2: Petroleum pollution in the Black Sea and the İstanbul Strait (5)

İstasyonlar / Yıllar	Karadeniz	İstanbul Boğazı	
		giriş	çıkış
1997	44,6 µg/L	43,1 µg/L	66,8 µg/L
1998	16,1 µg/L	9,5 µg/L	45,3 µg/L
1999	126,9 µg/L	13,4 µg/L	25,2 µg/L
2000	64,8 µg/L	19,2 µg/L	44,5 µg/L
2001	97,7 µg/L	148 µg/L	87,2 µg/L
2002	209,2 µg/L	45,5 µg/L	752 µg/L
2003	47,8 µg/L	255 µg/L	110 µg/L
2004	277,1 µg/L	130 µg/L	1,22 mg/L.

Petroleum pollution (Max. Values) in the sediments of the İstanbul Strait and Marmara Sea is shown in Table 3.

Table 3: Petroleum pollution in the sediments of the Bosporus and Marmara Sea(5)

Years/ Stations	İstanbul Strait	Marmara Sea
2000	6.2 mg/g	5.3 mg/g
2001	601.1 µg/g	1 mg/g
2002	754 µg/g	1.7 mg/g
2003	341.1 µg/g	2.2. mg/g
2004	243.50 µg/g	1.151 µg/g

The data obtained as a result of the measurements showed that the amount of petroleum pollution both in sea water and in the sediment of Istanbul Strait exceeds the world standards.
The amount of marine creatures that is sold in Istanbul fish market between 1997 and 2004 is shown in Image 4.
Consuming marine creatures from the seas with intense hydrocarbons and carcinogenic effect around the the Istanbul Strait, arises bad results in terms of human health.

Table 4: According to years, the amount of marine creatures incoming to Istanbul fish market(Compiled from the Ministry of Food, Agriculture and Livestock)

Years	The amount of fishery products coming from Istanbul fishery market (ton)
1996	24563
1997	20776
1998	23921
1999	24401
2000	25631
2001	36770
2002	37238
2003	39590
2004	26364

5. Petroleum Pollution due to the Marine Accidents in Istanbul Strait

The biggest accident that took place in the Turkish coast was Independent on 15.11.1979. 20,000 tons of petroleum were poured into the sea and 70,000 tons of oil were burned. Unfortunately, there has not been a quantitative measurement of petroluem pollution in the Istanbul Strait and Marmara Sea, and marine life. The second major accident was with the 100.000 tons tanker Nassia, on 13.03.1994. 2000 tons of petroleum was spilled out and 20,000 tons of petroluem burned. Accidental pollution measurement was done only 1 month after the accident. The amount of pollution found in the sedimentte (µg / g) is: 110 in Karaburun, 125 in Poyraz, 270 in Altinkum and 260 in Beykoz. at the beginning the strong winds and currents of the accident were seen to spread rapidly throughout Marmara the thick layer petroleum covering the sea surface . The above-mentioned seawater petroleum pollution is measured 1 month after the accident. The pollution created by the petroleum layer which initially covered the sea was not detected completely due to administrative reasons and Turkey did not receive the required insurance. The amount (µg / g) found in mussels after this accident in the sea creatures was 250 in Altınkum in September 1994, 144 in April 1994, the amount in the algae (µg / g) Ulva lactuca 175.5, Ceranium rubrum 290,0; Cystoseria barbata 90.80 dir. (5)

The Volgoneft - 248 tanker was shattered and settled by the storm in Ambarli while it was loaded with 4365 tons of fuel oil on 29. December 1999. 3.086 tons of fuel oil flowed into the sea. The resulting pollution was found to be 14 g / L initially in seawater and 567.6 µg / L after 20 months. The highest amount in sediment was 441 µg / g.(40 times more than standard) (5)

The merchant ship GOTİA hit the Emirgan dock on 6.10.2002 and 25 tons of fuel oil was poured into the sea. The highest value in seawater was 813.5 mg / L in the Throat, 7.3 mg / L in Haliç, 27.4 mg / L in Yenikapı, 0.30 mg / g in mussels and 179 mg / in alga.

To prevent environmental pollution, to minimize financial losses and to introduce a general traffic scheme has been considered by the competent authorities.

The Turkish Straits Vessel Traffic Services ("Vessel Traffic Services"), taking into consideration the national and international rules, in order to increase the environmental safety against the risks and hazards that may arise from maritime traffic safety and maritime traffic within the determined service area in the Istanbul Strait, Canakkale Strait and the Sea of Marmara

The Turkish Straits Vessel Traffic Services ("Vessel Traffic Services") (TSVTS) system was established and started to serve on December 30, 2003. In order to increase the safety of the environment against the risks and hazards that may arise from maritime traffic safety and maritime traffic within the determined service area in the Istanbul Strait, Dardanelles and Marmara Sea taking into consideration national and international rules. (8)

6. Methods of petroleum Pollution Prevention and Cleaning

Today, the methods used to prevent and spread the spread of petroleum pollution are:

Burn: Petroluem poured into the sea can be burned and removed from the environment in areas far away from the shore, but this process is not suitable for long-run oil in the sea. Because volatile compounds that are easily combustible are already away.

Enclosure with Barriers: Applicable if the water in the harbor and coast is stagnant. Spilled petroleum is sideded by floating pipes. The petroleum that is prevented from spreading is after cleaned by ladles. Waves can deactivate this method.

Using Water Foam: Pressurized air around and under the petroleum pollution zone prevents it from dispersing and is effective in shallow waters.

Chemical Substance Use: It is a method that can be used on offshore and wavy conditions, using chemicals to enclosure the petroleum around with a gelatinous outer layer.

Mechanical Cleaning: It is carried out by a system mounted on board. Petroleum on the surface is cleaned by mechanical ways. It is effective in calm seas and the petroleum that is collected can be used.

cultivating Microorganisms: Microorganisms are exploited to break down hydrocarbons. The decomposition of petroleum is accelerated by cultivated microorganisms. Without appropriate conditions, oxygen consumption can increase and cause damage to the ecosystem. It is not a very common method.
Sorbent Usage: It is a traditional and old method of removing petroleum residue in small quantities.
Precipitation Method: In areas with petroleum accumulation, petroleum is deposited on the bottom using materials such as fine sand, brick and dust.
To emulsify: For this purpose mostly dispersants are used and it is desirable to disperse the petroleum into small pieces in the water layer by lowering the surface tension. in this way petroleum can be easily disintegrate by organisms and photolytic events. (4)
As a result of recent researches, Zhejiang University of China developed a material named "Grafen aerojel" with a mass of 0.16 milligrams per cubic centimeter. As well as being extremely easy to produce, it has attracted attention with its ability to absorb petroleum.(1 gram of airgel can absorb 68.8 grams of organic compound per second.) This makes the material a very important cleaner against petroleum spills in the seas. (4)

7. Current Situations of the Institutions at Petroleum Pollution

In order to intervene in the marine pollution that may occur in the rescue ship operations , examins of the Strategic Plan 2016-2020 Directorate General of Coastal Safety (which has undertaken the rescue of ships in Istanbul Strait) shows that; In 2000, the 2000 m barrier, 2 50m3 / h capacity oil skimmer, 4 floating 50m3 capacity floating resilient tank, and other pump and hydraulic power units needed for their mobilization were added to the rescue equipment inventory. (8)
Also In 2006; 1000 meters inflatable neoprene barrier, 2 skimmer (15 and 25 m3 capacity), 2 V configuration barrier and 2 mooring boats (Barrier-1 and Barrier-2) were added. At the same time, Tahlisiye II and Tahlisiye III boats are used as intervention boats for barrier pavement, collection and waste collection from the sea. In 2008, 4 more petroleum collecting oil skimmer devices (2 15 and 2 25 m3 / h capacity) marine pollution equipment were added to our inventory. In 2009, 1800 m air inflated barriers and equipment (3 diesel hydraulic power units, 3 diesel powered air compressor, 4 sets barrier repair kit and connection equipments) in anticipation of near completion of the shelf life of our barriers taken in 2000, Pollution Control Equipments and 2 Skimmer. In 2010, 150 meters fire barriers were provided. (8)
Improving the ability and capability of marine pollution that may occur in ship salvage operations
It is planned that the Fuel Collection Gear will be serviced in order to collect and heat petroleum derived wastes such as oil and fuel on the sea surface with a 15-ton lifting capacity, and to Improve the ability and capability of marine pollution that may occur in ship salvage operations. (8)
In the Büyükdere-Sarıyer where the Coast Guard Marmara and Straits Region Command is located, there are Absorbent pads and a floating barrier on the Search and Rescue ship.

CONCLUSION

This study shows that our country is threatened by petroleum pollution. The measurements made in the Istanbul Strait between 2000 and 2004 were higher than the standards. The currents coming from the Black Sea and Marmara Sea, the oil spills leaked from sea vehicles and the sea accidents are thought to have caused this situation. As a matter of fact, after the accident that took place in 2002, there has been a serious increase in the ratio of sediment and sea petroleum. This affects the economy, environment, marine life, fisheries and therefore human health negatively. The results obtained from measurement studies show that the accumulation of hydrocarbons in the Istanbul Strait seawater and sediment is well above the world boundary values. The marine products obtained from these waters are also affected by these hydrocarbons, which have a cancerogenic effect in terms of human health. Therefore, with the hydrocarbons formed by the disintegration of petroleum spills originating from ships are passed to humans by nutrition, our health is affected negatively. In order to prevent this situation, it is thought that the seafood products produced from the Istanbul Strait and the surrounding seas should be inspected for microorganisms and

compounds harmful to human health before reaching to the consumer. There is a great importance to prevent sea accidents in order to prevent petroleum pollution in Istanbul Strait which is a difficult transition due to the nature. It is clear that the Turkish Straits Vessel Traffic Services, which was established in 2003 to arrange ship traffic, has made great contributions to the prevention of accidents. The indicator of this is that there are no accidents that create serious oil pollution in Istanbul Strait from the day it was established to this day. In order to reduce marine pollution and to prevent sea accidents in the Istanbul Strait, ships should be encouraged to get guidance and actual exercises should be carried out so that the responsible institutions will be involved.

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